Examination of the Thoracic Aorta by Computed Tomography

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In the few years since its introduction, computed tomography (CT) has established its usefulness for several aspects of thoracic imaging, particularly for evaluating mediastinal abnormalities, including aortic diseases. In many cases, noninvasive assessment of the aorta by CT may make aortography unnecessary. Furthermore, CT has advantages over other noninvasive techniques. Unlike ultrasound, it can image all parts of the thoracic aorta, and it is not limited by the configuration of the chest wall or by concomitant lung disease. Unlike intravenous digital subtraction angiography, a promising new technique, it clearly delineates pathology surrounding the aorta, and it is not limited by registration artifacts.

The main applications of CT to the thoracic aorta have been in assessing aneurysm, dissection, and postoperative complications. CT is not recommended for diagnosis of suspected acute transection. Although it can assist in the delineation of congenital conditions such as coarctation, transposition, or arch anomalies, it is not the primary technique for their diagnosis.

AORTIC ANEURYSM

Plain radiographs are often diagnostic and sufficient by themselves for demonstrating the presence and anatomic relationships of an aortic aneurysm. When they are not, CT can be used to verify the diagnosis and to show the location, size, and extent of the aneurysm (Fig 1). Since the upper limit of aortic caliber is about 40 mm in the ascending limb and about 30 mm in the descending, diameters in excess of these measurements can be considered aneurysmal. In practice, CT is usually invoked for assessment of discrete, localized dilation of the aorta. Diffuse dilatation is usually not an indication for CT scanning unless chronic aortic dissection is suspected as its cause.

CT has several advantages with respect to aortography in assessing a suspected or known aneurysm.12 First, CT does not require arterial catheterization and hospitalization. CT does necessitate intravenous injection of contrast medium, with the attendant risk of reaction to the medium, but CT avoids the risks of systemic embolization or arterial bleeding associated with arterial catheterization. Second, CT shows more of the aneurysm than just the contrast column. Aortography can underestimate the size of the aneurysm, since only the contrast column is visualized. Third, CT

![Figure 1. Calcified atherosclerotic aneurysm (arrow) of proximal aortic arch. In some cases, precise location of the origin of an arch aneurysm with respect to the left subclavian artery can be difficult to ascertain with CT alone, making aortography necessary.](image-url)
is more sensitive for detecting intimal calcification and it shows better the relationship of the calcification to the aortic margin. This relationship is important in distinguishing simple aneurysm from dissection. In aneurysm, intimal calcification is peripheral, near the aortic margin. In dissection, calcification may be displaced inward. Fourth, CT assesses better structures surrounding the aneurysm. Sometimes a suspected aneurysm is really another kind of mediastinal mass, in which case aortography is not helpful, and CT is clearly the imaging procedure of choice. In cases of confirmed aneurysm, CT is the preferred technique for showing and displacement or erosion of adjacent organs. In cases of leaking aneurysm, CT will show periaortic hematoma or pleural fluid collections that are invisible on aortograms.

In most cases, CT supplies all the information the surgeon needs in order to decide whether to operate and to plan his approach, and the patient can usually be spared aortography. In some cases, however, particularly when the aneurysm originates in or near the aortic arch, aortography is necessary. Because of the complex anatomy of the arch and the likelihood of its being distorted by the aneurysm, a series of CT cross-sections may not clearly show whether the origin of the aneurysm is in the arch itself or just distal to the left subclavian artery, a critical anatomic relationship affecting the decision to operate and the surgical approach.

Aortic Dissection

In acute aortic dissection, findings on plain radiographs are often abnormal, but seldom diagnostic. Findings include mediastinal widening, enlargement of the aorta, pleural or pericardial effusion, and separation of aortic calcification from the aortic margin. Of these, only displacement of intimal calcification is specific for dissection, but it is seldom present. Aortography has been the standard for diagnosis of dissection, but contrast-enhanced CT provides a noninvasive alternative that is applicable to many cases of suspected dissection.

CT findings in dissection mirror the aortographic findings. The diagnosis is clear-cut when the contrast column is split into two or more channels by intervening intimal flaps (Fig 2). Delayed opacification and washout of one of the aortic channels can usually be demonstrated with dynamic scanning combined with bolus injection of contrast agent (Fig 2). In cases in which one of the channels is thrombosed or filled with stagnant hematoma so that no contrast agent enters it, a confident diagnosis of dissection can still be made if inward displacement of intimal calcification can be identified. Associated findings that are not diagnostic include irregular caliber of the aorta or a discrepancy in caliber of the ascending and descending limbs, intraluminal thrombus, periaortic hematoma (Fig 2), and pleural or pericardial fluid collection.

The advantages of CT with respect to aortography are that CT does not require arterial catheterization; it does not require precise positioning of the patient in order to project an intimal flap in tangent; and it better detects displacement of intimal calcification. The limitations are its small field of view (aortography, on the
other hand, can show the entire thoracic aorta on a single frame) and its inability to show aortic regurgitation, coronary or brachiocephalic vessel occlusion, the sites of intimal tears, the pathways by which the aortic lumens are filled, or the collateral pathways by which proximally obstructed aortic branches are perfused. Although no large, controlled series has compared the sensitivity and specificity of CT and aortography for the diagnosis of dissection, the experience of some authors indicates that CT is probably as sensitive as aortography. In some cases, CT has detected intimal flaps in locations where they were not seen on aortograms because they were not projected in tangent to the x-ray beam.

Despite its limitations, CT is useful in many cases of suspected aortic dissection because it is noninvasive. We use CT as follows: (1) in patients who are not candidates for operation because of advanced age or serious underlying medical conditions; (2) in patients who are not candidates for operation because the dissection is suspected to be confined to the descending aorta, and medical, rather than surgical, treatment is anticipated; (3) in patients with unexplained chest pain in whom myocardial infarction has been excluded, but in whom the suspicion of dissection is not high enough to warrant aortography for diagnosis.

**THE AORTA AFTER TREATMENT FOR DISSECTION**

Now that effective therapy has permitted patients with acute aortic dissection to survive, the long-term complications of aortic dissection are emerging. Patients who have had an operation or medical therapy for aortic dissection are at risk for re-dissection, extension of dissection, development of aneurysms or false aneurysms, aortic rupture, and suture dehiscence with separation of the graft from the native aorta. Plain films are relatively insensitive for detecting these complications. On the other hand, most physicians are reluctant to submit asymptomatic patients to aortography, which is more sensitive than plain radiographs, but more invasive.

We have found CT convenient as an outpatient procedure for evaluating the treated aorta. We have identified progressive enlargement of the aorta in several patients, leading in one case to an operation for stabilization. In other patients, we have identified suture dehiscence at the site of grafting, manifesting as the appearance of small amounts of contrast-enhanced blood in the space between the graft and native aortic wall. In two patients, separation of graft and native aorta was severe enough to require reoperation. In one of these patients, plain radiographs gave no indication of the severe dilation of the ascending aorta around the graft (Fig 3).

In the majority of postoperative patients, the false lumen remains patent distal to the graft. A similar finding has been reported in angiographic series. It should be considered a normal result, rather than a shortcoming of the operative approach. The beneficial effect of surgery probably derives from stabilization of the weakened portion of the aorta rather than from obliteration of entry points into the false channel.

**OTHER AORTIC CONDITIONS**

A few reports have demonstrated CT findings in congenital aortic conditions such as coarctation, pseudocoarctation, transposition, and arch anomalies. For coarctation and pseudocoarctation, aortography with pressure measurements is preferred over CT. Transposition usually requires more extensive angiographic and hemodynamic assessment than provided by CT. Arch anomalies can usually be diagnosed from plain radiographs supplemented by esophagrams.

Acute aortic transection is sometimes diagnosable by CT, but both sensitivity and specificity are limited. The problems are that the subtle changes in aortic contour indicating transection with false aneurysm may be missed on a series of contiguous CT slices because of the complicated anatomy of the distal arch and the difficulties in scanning uncooperative, traumatized patients. Furthermore, significant trauma to a brachiocephalic artery requiring operative repair can easily be missed on CT. Last, the identification of a mediastinal hematoma, even in a periaortic location, does not mean that the aorta is the site of hemorrhage. For all these reasons and because aortic transection is an emergency, aortography—the standard diagnostic procedure—should not be delayed.

**CONCLUSION**

CT has provided a useful noninvasive technique for
assessment of acquired aortic diseases—aneurysm and dissection—and for follow-up of patients treated for aortic dissection. In many cases, CT provides an alternative to aortography, avoiding its risks and requirement for hospitalization.

REFERENCES
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